APPENDIX K

EXPRESS MAIL LABEL
NO.: EL386270487US

Appendix K will be understood and appreciated from the following detailed description, taken in conjuction with the drawings in which:

Fig. 73 is a simplified illustration of a board whose image is to be analyzed; and

Fig. 74 is two simplified illustrations of a board whose image is being analyzed.

INTRODUCTION

A key problem in computer vision is the extraction of meaningful features from images. A popular approach is based on edge data.

A method for production of connected components composed of CELs (lists of edge elements generated using edge detection method producing single pixel contour elements or CELs) is now described.

OVERVIEW OF THE METHOD

General

The vector of CELCELs is arranged in a format called run length which means that the data is arranged in the sequence of scanning (sorted by y coordinate and then by x coordinate for every line). We can look at the run length format is a some kind of sparse raster format.

Reference is now made to Figure 73 which is useful in understanding a preferred embodiment of the present invention.

Raster to vector of edges image

Properties of CELCELs (basic cel)

A CEL (contour element) is a zero crossing vector which is defined on a pixel size rectangle that has four binary image pixels at its four corners.

The four pixels are assumed to be centered around the origin having coodinates P0,P1,P2 and P3.

The X and Y coordinates of the CEL are derived from the image coordinate system and are set according to the coordinates of the center of pixel P3.

In addition to the pixel grid coordinates there is also a sub pixel resolution coordinate system for each axis which is represented by an integer having n =

CEL_SUB_PIXEL_BITS bits. Thus the representable sub pixel coordinates are from 0 (representing 0.0) to 2n - 1 (which is SMALLER than 1.0 ,that is represented by 2n.

It is appreciated that 1.0 can not be represented in this number of bits since we typically need n + 1 bits of representation in order to be able to represent all integers from 0 up to 2n.

The CELReport structure preferably contain the following bit fields:

dir;

last;

first;

edge_code;

where:

edge_code:

defines the orientation of the CEL which goes from first_edge to last_edge:

Case 6 corresponds to a saddle situation(s) which is described below.

Case 7 is used for special cases of entities, which is discussed below.

first:

is the intersection point (in a cyclic coordinate system) of the cel with edge first_edge.

last:

is the intersection point (in a cyclic coordinate system) of the cel with edge last_edge.

The elements first and last are stored in a cyclic storage scheme.

The sub_pixel location of a point on an edge is determined by the edge on which that point lies. Thus a point on edge 0 with the coordinate 1 is above the point on edge 3 with a coordinate M - 1 The advantage of this scheme is that it allows us to represent ALL points in the sub-pixel with CEL_SUB_PIXEL_BITS bits since each vertex of the pixel coresponds to one edge with a coordinate of M (which CAN NOT be represented using only CEL_SUB_PIXEL_BITS bits) and to another edge with a coordinate of 0 (which is representable).

dir:

0 if the area of white material (elsewhere referred as negative DOG signis) to the left of the oriented cel line going from first_edge to last_edge.

1 if the area of white material (elsewhere referred as negative DOG signis) is to the right of the oriented cel line going from first_edge to last_edge.

Input and output

The input to the method is a vector of Contour Elements (or CELCELs) which are single pixel edge elements generated using edge detection method. The output of the method is a connected components object which is a collection of highly sampled contours of the shapes in the input image. The connected components are the first form of full vector representation of edges of the input image in the system.

Parameters

The method has two input parameters that control its operation:

* The first parameter is the Close connected segments or Edge connection flag that instructs the method whether or not to perform chains association along the edges of the window. Chain association is used for further processing in the system in order to perform operations on groups of chains that describe a specific entity in the image.

* The second parameter Enclose white regions or Connect dir flag ,which is relevant when the edge connection option is used, instructs the method about the way association is preferably performed.

Operation

In general the operation of the method can be summarized as reordering of scanline data to polygonal data. In addition to that the method m performs some other topological operations to add information to the understanding of the input edges data.

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